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original article

Assessment of physical risk factors among artisans using occupational repetitive actions and Nordic questionnaire

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ABSTRACT

Aims: The aims of present study is to determine the level of exposure to physical risk factors of work related repetitive movements in the upper limbs among the artisans in Isfahan, using occupational repetitive actions index and the Nordic Questionnaire.

Material and Methods: In this cross-sectional study, the study population consisted of 94 males employed in Artisan production. The tools that be used for assessing physical ergonomic risk factors among artisans was Nordic Questionnaire and OCRA index. The different handicraft tasks and work activities included: Simple etching, embossing, reticular embossing, enameling, tiling, illumination, inlay, copper smithing and, miniature painting have been chosen for the study. The Study was carried out on the both left and right hands. The results were analyzed by statistical tests included Chi square, Kruskal Wallis and one-way variance analysis.

Results: The highest OCRA index score was related to simple etching job, and the other tasks such as embossing, copper smithing, reticular embossing, tiling, miniature painting, and illumination were in lower risk category. Our finding showed that there are a significant difference between OCRA scores of the various jobs (P value < 0.001), and also the relationship between OCRA index and the type of jobs was statistically significant (P value < 0.001). Risk level in the right hand was significantly higher than the left hand (P value < 0.001). Moreover, in both right and left hands, OCRA index was different among several types of jobs (P value < 0.001).

Conclusion: Our assessment showed that in overall there are different physical risk factors among artisans which make them susceptible to musculoskeletal disorders.

Key words: Ergonomic assessment, musculoskeletal disorders, Nordic questionnaire, occupational repetitive actions index

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INTRODUCTION

Musculoskeletal disorders are major problem in occupational health, and a main cause of disability in different countries.[1,2] It is estimated that more than 40% of occupational costs in the world is taken up by work related musculoskeletal disorder (WMSDs')[3] which are include medical costs, lost

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work time, workers compensation and etc.[4] The amount of these expenditures is considerable as WMSDs' cause 45 to 54 billion Dollars lost per year only in the United States.[5]

The relation between physical workplace exposure and WMSDs has been proved.[4] However, most researchers have indicated that WMSDs is the multi factorial disease in which physical, psychosocial, organizational, and individual risk factors interfere.[6] Physical workplace risk factors is included the awkward postures tasks, force demands, repetition, duration of exposure and vibration while individual characteristics are age, gender, anthropometry, muscle strength, and physical fitness as well organizational and psychosocial factors are categorized as work load, time pressure, job stress, lack of social support and job dissatisfaction.[2] Various studies have investigated different levels of these factors and indicated their relations with incidence of WMSDs among a variety of occupations.[6] There is a major interest among ergonomists, occupational health practitioners, and employers for accurate assessment of workers exposure to those risk factors that may contribute the most in developing WMSDs. Exposure assessment have focused on physical risk factors and workload as more than 6000 scientific articles have been published about this subject since 1970.[2,7]

To assess physical risk factors, a wide range of exposure assessment techniques have been developed which are categorized as self-reported method, observational method and direct measurement.[4] The most frequently used methods are Observational approach which are widely used for posture assessment, determining physical workload and conducting research ergonomics. There are a large numbers of different observational methods which none of them are identified as a comprehensive method for all purposes while each approach is designed for unique goal.[8] Moreover, self-reports methods based on questionnaire are applicable to a various workplaces and able to estimate WMSDs symptoms among a large numbers of populations because of low costs for selecting sample size.[6] In order to have the more comprehensive assessment, it would probably be useful to combine such approach according to the type of the tasks and the work activity as well the goal of the job. Particularly interviews could increase the validity of assessment and decrease the probability of missing hazardous factors in the job.[8] As artisan is a type of job in which the most tasks are done entirely by hands and the upper limbs are completely involved, in this study, the upper limb exposure to physical risk factors and repetitive movements were assessed by Occupational Repetitive Actions (OCRA).[9] This approach is categorized to assess workload in upper limbs which its advantages included considering to recovery periods, and estimating the worker risk level by taking into account all the repetitive tasks in complex job outweigh its limitations such time consuming. As well studies showed the moderate correspondence between OCRA, ACGIH HAL and the strain index.[8] Furthermore, some studies have utilized OCRA for the assessment of ergonomic risk factors in the upper limbs in metal industry[10] and also among tailoring, shoe making, leather works, and carpet weaving professions in Iran[11] which showed that the higher OCRA index in the task, the more prevalence of upper limbs WMSDs have been occurred.

As above said, to improve the validity of our evaluation we also use Nordic questionnaire to determine the amount of musculoskeletal disorders symptoms among study population.[12] Therefore the aim of this study is to assess exposure to ergonomic risk factors among artisans as one of widespread occupations in Iran OCRA index and self-reported questionnaire.

MATERIALS AND METHODS

This is a cross-sectional study that was carried out among artisans in Isfahan, and the effects of repetitive action were assessed on the operatives' upper limbs in both left and right hands separately.

In this study, the samples were taken from the different artisans whose jobs were Embossing, Etching, Reticular Embossing, Enameling, and Fillet. All of the research population was men and the numbers of people who participated in our research were 94 whom from each separate artistic job 10 persons have been selected. Sampling was based on the simple non-probabilistic method. The inclusion criteria were the lack of the acute diseases and accident in musculoskeletal system. Patients with a history of surgery in their limbs or back were excluded from the study. The purpose of the study was explained to all the subjects who were selected for the study. And all of them signed the written consent. The study was approved by the Committee of Research Ethics at Isfahan University of Medical Sciences. Combination of methods have been used for data collection which included observation (for job and tasks analysis that contain repetitive movements), and interview (workers explaining how the work was done, their musculoskeletal disorders symptoms, and assessment of body movements during work). Our approach for doing this study was Nordic Questionnaire method (NMQ), and Occupational Repetitive Action (OCRA). OCRA method was used to analyze different jobs and tasks and to evaluate quantitative index for determination and classification of ergonomic risk level among various repetitive work activities. The overall index of OCRA is calculated by dividing the total number of technical actions performed during the work period on the total number of recommended technical actions.[8] Also OCRA checklist is used as a preliminary screening tool. OCRA score which is classified 1 or less means low risk level and it is acceptable that is placed in green zone. As well OCRA score between 1 and 2 is regarded as negligible risk, placed in green/yellow zone. OCRA score between 2 and 4 indicates moderate risk, placed in yellow zone. OCRA score over 4 means severe risk level or presence of risk, and placed in the red zone.

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The prevalence of musculoskeletal disorders and symptoms among workers was assessed using the NMQ. This is a self-reported questionnaire which its validity and reliability has been determined in the other studied.[12]

Analysis of variables was carried out using statistical tests such as Chi square, independent t, Kruskal-Wallis, and one-way variance analysis, with the use of SPSS 18 software.

RESULTS

Analysis of our results showed that their age ranged from 17 to 80 years old, with a mean of 36.09. The mean of population work experience was 17.53 ± 14.20 years, the least experience being one year and the most 70 years in this job. Table 1 shows demographic characteristics of the artisans.

The results obtained from Nordic Questionnaire showed that 50% of workers in the study suffered from pain and discomfort in at least one of the upper limbs like shoulder, elbow, wrist, and fingers in the last 12 months. The distribution of musculoskeletal disorders and symptoms among study population were as follows during past year though the percent of disorders in shoulders, elbow, wrist and fingers were 40.4% (38), 13.8%, (13) 9.6% (9), 14.9% (14) respectively.

Table 1: Demographic characteristics of the study population (*N* = 94)

Characteristics	Values
Age mean(SD)	36.09 (13.23)
Precedence of work mean(SD)	17.53 (14.2)
Weight mean(SD)	70.29 (10.32)
Height mean(SD)	172.26 (7.8)
Smoking *n*(%)	
Yes	14 (14.9)
No	80 (85.1)
Precedence of Disease *n*(%)	
No Disease	88 (93.6)
Disease	6 (6.4)
Hand (%)	
Right	88 (93.6)
Left	6 (6.4)
Education level (%)	
Illiterate	5 (5.3)
Diploma and lower	79 (81.1)
Bachelor and Higher	10 (10.7)

According to the independent *t* test, there was no relationship between age, height, and weight, with musculoskeletal disorders ($P > 0.05$). But there was a significant relationship between length of work experience and musculoskeletal disorders, ($P = 0.03$). The mean of work experience in people who had at least one disorder in the past year was 23.3 ± 3.8, and in people who had no complaint was 14.8 ± 2. Also, our results indicated that there is not any relationship between work experience, and absenteeism due to musculoskeletal disorders ($P > 0.05$).

Table 2 shows the percentage of disorders in the shoulders, elbows, wrists and fingers among right/left handed people. There is a significant relationship between shoulder disorders and right/left handed subjects as left-handed people showed the more disorders in their shoulders than right handed. Also, the prevalence of elbow disorders among left-handed was significantly higher than right-handed ($P = 0.001$). However, although the distribution of symptoms in wrist among right-handed was more than left-handed (13.7%), it was not observed any relationship between wrist and fingers disorders with the hand behavior among study population [Table 2].

The distribution of musculoskeletal disorders in the upper limbs among different artisan jobs can be seen in Table 3, as shown the highest percentage belongs to the inlay and copper smiting professions. We did not observe any significant difference in the distribution of musculoskeletal disorders in upper limbs amongst various handicraft jobs.

Figure 1 shows WMSDs risk level of the right and left hand among artisans. As shown, the risk level in red zone on the right hand is higher than left hand though the red risk level was observed in the right hand of 83% of the participants. Moreover, we observed that the distribution of risk level in red zone in right hand among study population is significantly higher than the left hand (*P* value < 0.001).

Table 2: Percentage of upper limbs disorders among right/left handed people

Upper limbs	Handed habitude	No-disorders	Disorder in right limb	Disorder in left limb	Disorder in both limbs	*P* value
Shoulders disorders	Right-handed people	60.2	10.2	3.4	21.1	$P<0.05$
	Left-handed people	40	0	40	20	
	Total	59.1	9.7	5.4	25.8	
Elbow disorders	Right-handed people	87.5	5.7	0	6.8	$P=0.001$
	Left-handed people	83.3	0	16.7	0	
	total	87.2	5.3	1.1	6.4	
Wrist disorders	Right-handed people	86.4	8	0	5.7	$P=0.628$
	Left-handed people	100	0	0	0	
	Total	87.2	7.4	0	5.3	
Fingers disorder	Right-handed people	85.2	11.4	2.3	1.1	$P=0.221$
	Left-handed people	83.3	0	16.7	0	
	Total	85.1	10.6	3.2	1.1	

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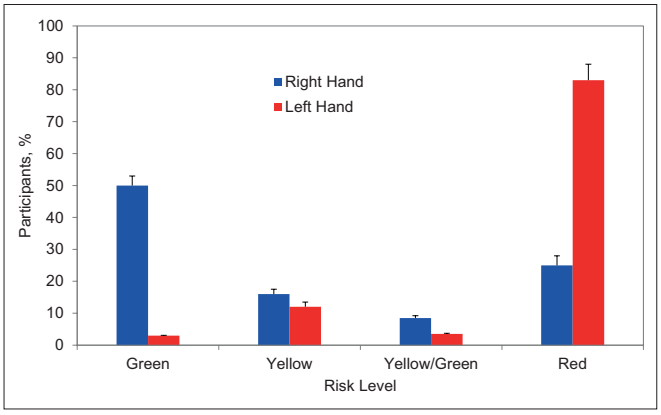

Figure 1: The distribution of WMSD risk levels in right and left hand among study population

The mean of repetitive activities in the OCRA index for right hand were 16.1 ± 1.7 and for the left hand were 4.2 ± 0.9. The paired *t* test showed that the mean of risk level in the right hand is much higher than the left hand.

Table 4 presents different handicraft jobs together with mean OCRA index value for the left and right hands. Also variances analysis test indicated that, in both right and left hands, the mean of OCRA index is not the same as different jobs (*P* value < 0.001).

Table 3: The distribution of musculoskeletal disorders in the upper limbs in various handicraft jobs, with distinction of job groups (*n* = 96)

Job title	Shoulders *n*(%)	Elbow *n*(%)	Wrist *n*(%)	Fingers *n*(%)
Etch work	4 (66.7)	0 (0)	2 (33.4)	0 (0)
Reticular embossing	4 (40)	1 (10)	2 (20)	3 (30)
Filleting	2 (22.2)	2 (20)	1 (10)	2 (20)
Etching	4 (40)	0 (0)	1 (10)	0 (0)
embossing	5 (50)	1 (10)	0 (0)	1 (10)
Copper smiting	4 (40)	3 (30)	2 (20)	2 (20)
Enameling	3 (30)	1 (10)	1 (10)	1 (10)
Miniature painting	3 (30)	1 (10)	1 (10)	1 (10)
Inlay	7 (70)	3 (30)	2 (25)	2 (25)
Tiling	4 (50)	0 (0)	0 (0)	1 (10)
Total	38 (40.9)	12 (12.8)	12 (12.7)	14 (14.9)
P value	0.15	0.16	0.44	0.66

Table 4: The mean of OCRA index among different handicraft jobs for the left and right hands

Type of job	Left hand (Mean ± SD)	Right hand (Mean ± SD)
Etching Work	1.11 ± 0.26	2.8 ± 0.66
Reticular Embossing	5.82 ± 1.26	16.92 ± 2.51
Filleting	0.19 ± 0.19	3.82 ± 0.9
Simple Etching	17.35 ± 6.74	37.99 ± 7.55
Embossing	5.23 ± 2.20	19.46 ± 5.67
Copper Smiting	5.91 ± 0.77	18.74 ± 2.44
Enameling	0.9 ± 0.9	15.52 ± 6.46
Miniature Painting	0 ± 0	8.81 ± 1.84
Inlay	4.67 ± 3.03	21.98 ± 8.42
Tiling	0 ± 0	10.64 ± 1.03
P values	< 0.001	< 0.001

DISCUSSION

Results of this study shows that in regarding to the type of the artisans work and tasks as well their work environment, artisans are to be taken as part of the stressful and repetitive activities. Also the study indicates that the prevalence of musculoskeletal disorders is high in the handicraft jobs, in that 50% of participants in the study had musculoskeletal disorders. Based on the participating workers own admissions, musculoskeletal disorders in the shoulders and fingers are widespread. In study among Bamboo Basket Making in India, they showed the same result as low back pain, upper arm and shoulder pain was respectively the major problems of the subjects. The main risk factor in this study was prolonged sitting and awkward postures especially in upper limbs that it was also widespread among artisans in our study. Furthermore, non-ergonomic chairs and non-organized time working were the other reasons which were effective on the distribution of WMSDs.[13] In another study among fish processing industry, it was revealed that neck and upper limbs disorders were common especially among women. The main reason for the upper limbs disorders among fish workers were their extremely repetitive work tasks which these results are consistent with our finding among artisans.[14] We observed in our study that the main reason for development of musculoskeletal discomforts could be long hours of intense activities and repetitive movements of the upper limbs coupled with short periods of rest and pause in the work process. This means, attention must be focused on the risk factors related static tasks. Elimination of the risk could be an effective step toward improvement of work conditions and prevention of WMSDs. Based on our results, measures should desperately be taken to improve work conditions. As other studies shown ergonomic interventions are significantly able to reduce WMSDs risk factors.[15] The artisans workplaces are included the uniqueness conditions which is necessary to perform specific ergonomic programs to fully address all WMSDs risk-factors. Therefore, in order to prevent of ergonomic risk factors, it is recommended to implement participatory ergonomics intervention together with redesign of the workplace and tasks. However, to design the well-performed ergonomic interventions among Iranian artisans need to the following researches due to exclusivity of their tasks. In this study no relationship was observed between demographic characteristics of the subjects and WMSDs while due to increasing in the length of the work experience, the probability of WMSDs increase significantly. Other studies showed that gender make a significant difference in the prevalence of WMSDs as females were most affected by MSD in earlier research. Moreover, young age groups reported more WMSDs complaints in self-reported studies.[16,17] However, in a study among Turkish dental students, it was shown that gender did not have any significant effect in musculoskeletal symptoms.[18] Our findings showed that musculoskeletal symptoms were more among left-handed people as they showed much more complaint in shoulders,

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elbows and fingers than the right-handed artisans which was in consistent with left-handed dental students who suffered extra from neck and shoulder pain in compared to right-handed students.[18] In spite of this, the few numbers of left-handed artisans in our samples (6.4% of all study population) may be a confounding factor in the presented results. The distribution of musculoskeletal symptoms among different types of artisan jobs was not significantly different as it was more in shoulders than the other upper limbs. Furthermore, an Inlay job was the work activity with the further shoulder complaints although its difference was not statistically significant. The same musculoskeletal symptoms amongst various artisan jobs might be due to the same work activities and tasks in these jobs. Nevertheless, the few numbers of subjects in each job category in this study make it difficult to conclude precisely about the difference of musculoskeletal distribution among various artisan job titles.

In this study we used the self reported Nordic questionnaire for estimating WMSDs risk factors which this questionnaire concentrates on symptoms in an occupational setting. Despite all apparent advantages of this questionnaire, the main problems is its subjective nature which excessively relies on workers perceptions regarding to his/her pain and exposure which can be unreliable.[6] However, some studies declared that its reliability is acceptable and it is possible to estimate specific characteristics of work.[12]

A significant relationship between variables of risk level and percentage of musculoskeletal disorders in the upper limbs (P value = 0.001) observed in this study which conclusions can be drawn that an increase in risk level must be expected to be accompanied by an increase in occurrence of musculoskeletal disorders in various upper body limbs.[19] In other words, in the execution of different duties, an increase in the musculoskeletal disorders in upper limbs is observed as risk level increases, and as the number of actions per minute is high in occupations such as simple etching, embossing, reticular embossing, inlay, copper smiting, and the probability for WMSDs increase. Therefore, it can be asserted that a high percentage of musculoskeletal disorders in handicraft jobs have mean values of OCRA index that could be because of the work related repetitive technical actions, high power actions, continuous work with little rest, inappropriate body ergonomics, etc., OCRA have been used in a variety of the workplaces to assess repetitive movements and efforts of the upper limbs which we also used it for this target and it is applicable for these kinds of occupations like artisans. Other studies applied it any jobs in ceramic, jewelry, clothing and meat.[19] Other studies showed that method is highly associated with the occurrence of WMSDs as statistical regression test shows R = 0.92 between OCRA index and WMSDs incidence. But, using this method is highly depending on the training and the skills of the analyst.[20,21]

CONCLUSION

In conclusion, in our study it was observed that the prevalence of WMSDs among artisans is high and also there are different ergonomic risk factors which contribute and facilitate musculoskeletal disorders among this population. Moreover, the most ergonomic risk factors were awkward postures along with prolonged sitting and repetitive movements in upper limbs. Furthermore, non-organized time working was another main reason in the higly prevalence of WMSDs in artisans.

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